TABLE OF CONTENTS

LIST OF TABLES AND FIGURES iv

1.0 REVISED STATEMENT OF WORK 1

1.1 INTRODUCTION 1

1.2 SCHEDULE 3

1.3 TECHNICAL DESCRIPTIONS 7

1.3.1 Vegetation 7

1.3.1.1 Phytosociological Investigations 7

1.3.1.2 Plant Collection 9

1.3.1.3 Vegetation Map 10

1.3.1.4 Data Analysis 11

1.3.2 Forage Production 12

1.3.2.1 Grazing Exclosures 12

1.3.2.2 Photo Plots 14

1.3.2.3 Data Analysis 14

1.3.3 Soils 15

1.3.3.1 Soil Sample Collection 15

1.3.3.2 Laboratory Analysis 16

1.3.4 Small Mammals 17

1.3.4.1 Live Trapping 17

1.3.4.2 Collection of Animals for Laboratory Analysis . . 23

1.3.4.3 Pitfall Trapping 26

1.3.4.4 Night Spotlight Censuses 26

1.3.4.5 Bat Inventory 28

1.3.4.6 Other Investigations 29

1.3.4.7 Data Analysis 30

1.3.5 Large Mammals 32

1.3.5.1 Winter Surveys of Deer 32

1.3.5.2 Sex Ratio - Age Classes for Mule Deer . 36

1.3.5.3 Mule Deer Migration Route Determination 37

1.3.5.4 Mule Deer Pellet Group Counts 38

1.3.5.5 Overwinter Mortality Estimates 40

1.3.5.6 Elk 42

1.3.5.7 Feral Horses 43

1.3.5.8 Data Analysis 44

TABLE OF CONTENTS
Continued

1.3.6 Mammalian Predators 45
1.3.6.1 Large Predators 45
1.3.6.2 Small Predators 48
1.3.7 Avifauna 49
1.3.7.1 Songbirds 49
1.3.7.2 Gamebirds 50
1.3.7.3 Raptorial Birds 53
1.3.7.4 Data Analysis 54
1.3.8 Reptiles and Amphibians 56
1.3.8.1 Field Methods 56
1.3.8.2 Other Investigations 59
1.3.8.3 Data Analysis 59
1.3.9 Invertebrates 60
1.3.9.1 Field Methods 60
1.3.9.2 Laboratory Methods 61
1.3.10 Domestic Livestock 63
1.3.10.1 Field Methods 63
1.3.10.2 Data Analysis 64
1.3.11 Rare and Endangered Species 65
1.3.11.1 Field Methods 65
1.3.12 Remote Sensing 66
1.3.12.1 Color Infrared Aerial Photography . . . 66
1.3.12.2 Mapping 68
1.3.12.3 Analysis and Interpretation 68

TABLE OF CONTENTS

Continued

1.4 DATA SUMMARY AND ANALYSIS 69
1.5 USE OF EXISTING INFORMATION 71
1.6 REPORTS AND MEETINGS 73
1.6.1 Reports and Meetings 73
1.6.2 Annual Reports 73
1.6.3 Final Report 74
1.6.4 Meetings 75
2.0 PROGRAM MANAGEMENT 76
2.1 PERSONNEL AND PROGRAM ORGANIZATION 76
2.2 QUALITY ASSURANCE/QUALITY CONTROL 79
2.3 EQUIPMENT AND FACILITIES 89
2.4 EXPERT TESTIMONY 71
3.0 LITERATURE CITED

LIST OF TABLES AND FIGURES

TABLE 1 - SIZES AND DISTRIBUTION OF SMALL MAMMAL LIVE TRAPPING GRIDS

FIGURE 1 - SCHEDULE FOR TERRESTRIAL BASELINE DATA ACCUMULATION PROGRAM

FIGURE 2 - TERRESTRIAL FINAL REPORT SCHEDULE

FIGURE 3 - PERMANENT VEGETATION TRANSECT SITES

FIGURE 4 - GRAZING EXCLOSURE DIAGRAM

FIGURE 5 - PATTERN AND SPACING OF TRAPPING STATIONS FOR THE LARGE (7.29 HECTARE) GRIDS

FIGURE 6 - PATTERN AND SPACING OF TRAPPING STATIONS FOR THE SMALL (0.81 HECTARE) GRIDS

FIGURE 7 - LOCATION OF SMALL MAMMAL LIVE TRAPPING GRIDS

FIGURE 8 - NIGHT SPOTLIGHT ROAD TRANSECT ROUTE FOR MAMMALS AND OWLS

FIGURE 9 - APPROXIMATE LOCATION OF AERIAL CENSUS FLIGHT LINES AND LOCATION OF UPPER LIMIT OF AVERAGE WINTER RANGE

FIGURE 10 - LOCATION OF THE 1-HECTARE LIZARD SAMPLING GRIDS

FIGURE 11 - ORGANIZATIONAL SCHEME SHOWING INDIVIDUALS HOLDING KEY POSITIONS

STATEMENT OF WORK AND ORGANIZATION
for
TERRESTRIAL BASELINE DATA ACCUMULATION PROGRAM
RIO BLANCO OIL SHALE PROJECT

1. REVISED STATEMENT OF WORK

1.1 INTRODUCTION

This document is a statement of the proposed scope for the terrestrial baseline data accumulation program for Federal Oil Shale Lease Tract C-a. It supersedes the technical and management proposals submitted by Ecology Consultants, Incorporated (ECI) to the Rio Blanco Oil Shale Project Management Consultant on August 16, 1974, by incorporating into its content many recommendations made by agencies reviewing the original specifications, and other modifications which resulted from careful field examination of the tract and contiguous region. The scope of work outlined herein is designed to collect 2 years of baseline terrestrial data and to perform the investigations described in the Federal Register, Volume 38, Number 230, Part 3, Oil Shale Lease Environmental Stipulations. The portion of this document pertinent to this study is the section on Collection of Environmental Data and Monitoring Program, as it relates to terrestrial ecosystems. Briefly, terrestrial communities will be analyzed in respect to species composition, abundance of individuals, species diversity and seasonal variations in

composition, abundance and diversity. Important species will be defined, and successional phenomena, including prediction of how the major biotic communities might change over time in the absence of oil shale development, will be discussed.

ECI will perform all field, laboratory, analytical and reporting activities as described in this Statement of Work using standard and accepted methods which will attain the depth and quality of data on terrestrial biota necessary for compliance with the lease environmental stipulations. The standardized techniques will develop a baseline norm against which future data, collected subsequent to start-up of mining and retorting operations, can be quantitatively compared.

Included in this 2 year program are field investigations of vegetation, small mammals, large mammals (including mammalian predators), songbirds, gamebirds, raptorial birds, reptiles, amphibians, terrestrial invertebrates and domestic livestock. An investigation of the existing use of rangeland vegetation by various types of herbivores will also be initiated.

Schedule of work and brief descriptions of techniques to be employed for each activity comprise the remainder of this Statement of Work.

1.2 SCHEDULE

ECI will implement and carry out field and analytical investigations according to the schedule illustrated in FIGURE 1. Field work will commence during early October, 1974, and continue on a bimonthly basis through September, 1976. Checkpoints for submission of reports are indicated, and a comprehensive final report will be developed and delivered on December 1, 1976, according to the schedule presented in FIGURE 2.

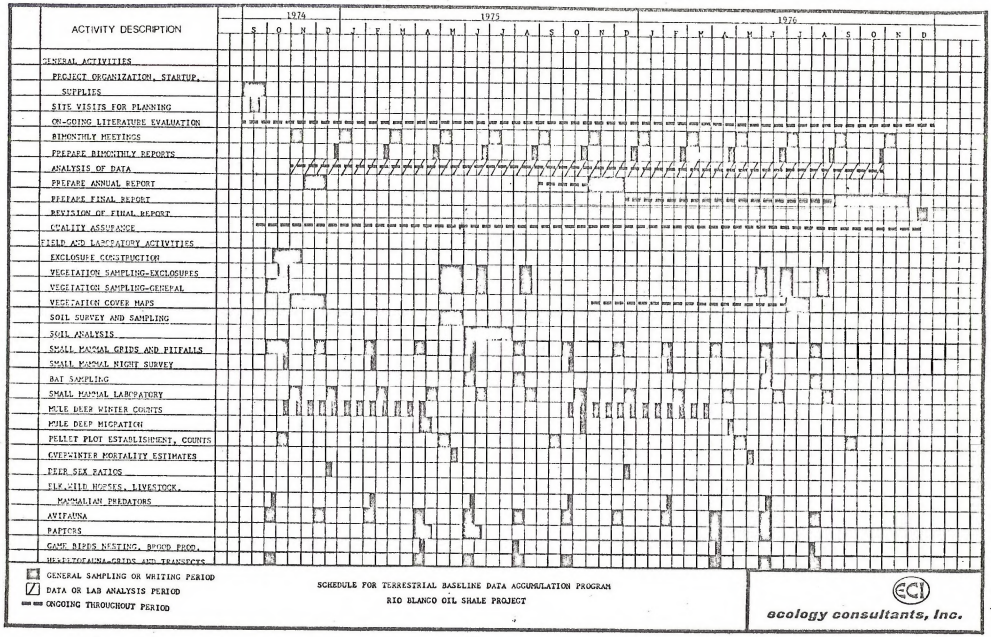

FIGURE 1. SCHEDULE FOR TERRESTRIAL BASELINE DATA ACCUMULATION PROGRAM

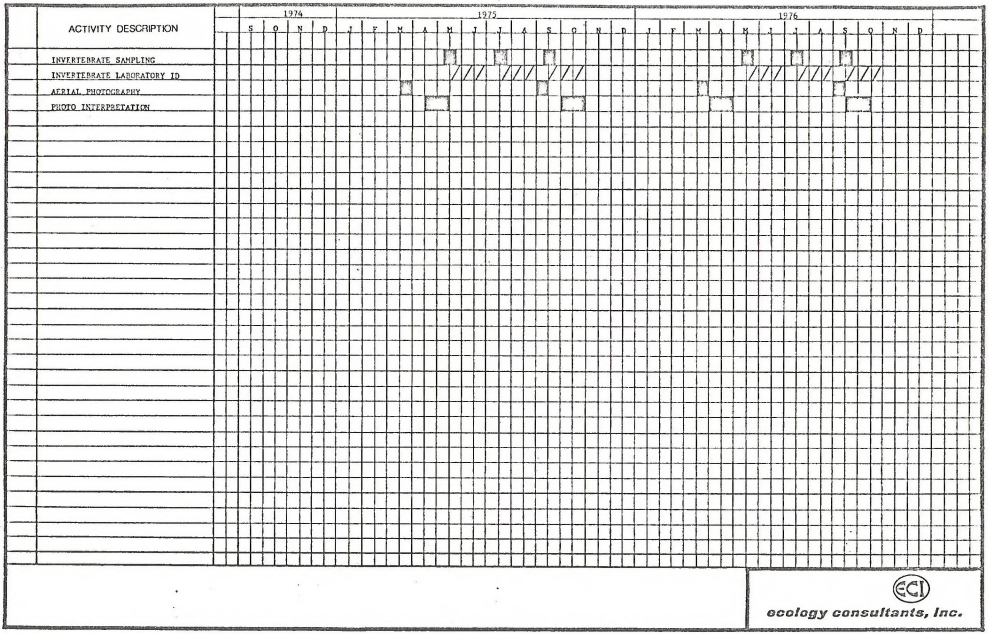
ACTIVITY DESCRIPTION
1974
1975
1976
S O N D J F M A M J J A S O N D J F M A M J J A S O N D
INVERTEBRATE SAMPLING
INVERTEBRATE LABORATORY ID
AERIAL PHOTOGRAPHY
PHOTO INTERPRETATION
ecology consultants, Inc.

FIGURE 1. (CONTINUED)

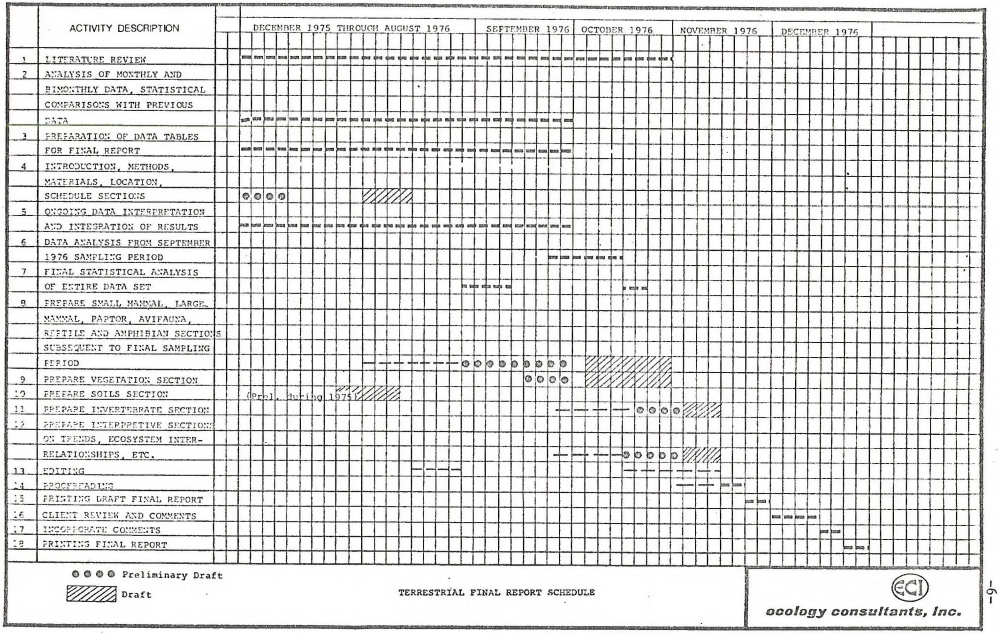
ACTIVITY DESCRIPTION
DECEMBER 1975 THROUGH AUGUST 1976
SEPTEMBER 1976
OCTOBER 1976
NOVEMBER 1976
DECEMBER 1976
1 LITERATURE REVIEW
2 ANALYSIS OF MONTHLY AND BIMONTHLY DATA, STATISTICAL COMPARISONS WITH PREVIOUS DATA
3 PREPARATION OF DATA TABLES FOR FINAL REPORT
4 INTRODUCTION, METHODS, MATERIALS, LOCATION, SCHEDULE SECTIONS
5 ONGOING DATA INTERPRETATION AND INTEGRATION OF RESULTS
6 DATA ANALYSIS FROM SEPTEMBER 1976 SAMPLING PERIOD
7 FINAL STATISTICAL ANALYSIS OF ENTIRE DATA SET
8 PREPARE SMALL MAMMAL, LARGE MAMMAL, RAPTOR, AVIFAUNA, REPTILE AND AMPHIBIAN SECTIONS SUBSEQUENT TO FINAL SAMPLING PERIOD
9 PREPARE VEGETATION SECTION
10 PREPARE SOILS SECTION
Prel. during 1976
11 PREPARE INVERTEBRATE SECTION
12 PREPARE INTERPRETIVE SECTIONS ON TRENDS, ECOSYSTEM INTER-RELATIONSHIPS, ETC.
13 EDITING
14 PROOFREADING
15 PRINTING DRAFT FINAL REPORT
16 CLIENT REVIEW AND COMMENTS
17 INCORPORATE COMMENTS
18 PRINTING FINAL REPORT
Preliminary Draft
Draft
TERRESTRIAL FINAL REPORT SCHEDULE
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FIGURE 2. TERRESTRIAL FINAL REPORT SCHEDULE

1.3.1 Vegetation

1.3.1.1 Phytosociological Investigations

The objectives of this study are to map the distribution and to determine the floristic composition of the major vegetational types on Tract C-a and its surroundings, providing a basis for future comparative studies. The method to be used incorporates the attributes of both the line-strip and the quadrat techniques to insure that reliable and high quality data are obtained in the field. This method, modified from Woodin and Lindsey (1954) and Potter (1957), will give data that can be analyzed for relative foliage coverage, relative coverage of the ground by the foliage of each species, relative coverage of the ground by the foliage of all species, square meters of foliage cover/hectare, frequency index, relative frequency, constancy, importance, and dominance for the herb, shrub, and tree strata; size-class distribution, relative basal area, square meters of basal area/hectare by species, and square meters of basal area/hectare of total species for the tree stratum; mean crown diameter, relative density, density/hectare by species, and density/hectare of all species of the shrub and tree strata. Productivity evaluations will be made in conjunction with the grazing exclosure program as discussed in Section 1.3.2.

Tentative site locations for placement of permanent transects have been chosen (FIGURE 3). There will be a total

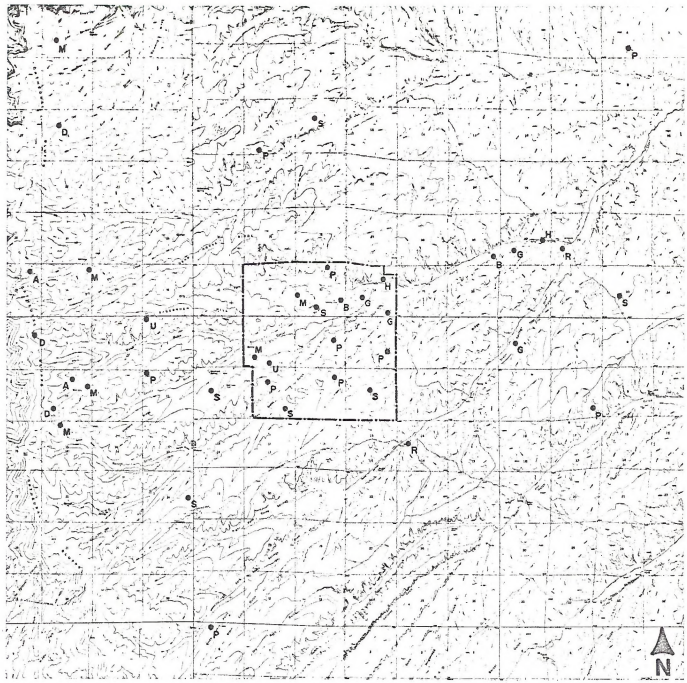

FIGURE 3 PERMANENT VEGETATION TRANSECT SITES

A	ASPEN	U	UPLAND MEADOWS
D	DOUGLAS FIR	H	SHADSCALE
M	MOUNTAIN BRUSH	G	GREASEWOOD
P	PINYON JUNIPER	B	RABBITBRUSH
S	SAGE	R	RIPARIAN

of 38 permanent transects with 15 of these located on Tract C-a. In conjunction with the permanent transect sites, 58 stratified random transects will be run each sampling period with 36% of these transects on Tract C-a. The total length of all the transect lines will be approximately 19,200 feet per sampling period with 39.6% of this involved in the permanent site locations. A standard transect length of 200' will be read in each of the 96 transect locations.

A standardized number of transects will be read in each of the major vegetative types utilizing the stratified random transects. This allows sampling a large number of habitat locations throughout the 6-zone area, producing a better statistical representation of the conditions to be found in each major vegetation type than would permanent transects. The permanent transects will serve as a basis of comparison for regional seasonal and yearly vegetation change. Any vegetation type identified after the preliminary evaluation will have established for it a permanent and at least one stratified random transect to be read in subsequent sampling periods. Sampling periods will be fall of 1974, spring, summer, and fall of 1975 and 1976.

1.3.1.2 Plant Collection

Plants will be collected, field identified, labeled as to plant community, location of community, date of collection, placed in a plant press, and transported to the laboratory to

be prepared, verified, cataloged, and placed in the ECI herbarium as voucher specimens. These will be used for comparative identifications of unknown species encountered in the sampling sites. This collection will ultimately include a complete inventory of individual species in each vegetative type and for the entire area.

Notes will be made concerning the condition of the plants within each sampling site, such as numbers and species which show evidence of disease, plants with insect galls, parasites, epiphytes, or other abnormal conditions. Photographs will be taken of unusual abnormalities. The field crews will be especially alert for species that may be sensitive to damage by air pollutants.

1.3.1.3 Vegetation Map

A preliminary map of all the vegetation types identified within the 6-zone study area (approximately 170 square miles) will be generated (Winter 1974) from aerial color infrared imagery and "ground truthed" during each field sampling period (1975). Vegetation association (type) boundaries will be drawn in ink on Mylar overlays of the film and then transferred to standard U.S.G.S. topographic maps for field use. Each vegetation association discovered through aerial photographic analysis and ground studies will be mapped on separate overlays to avoid confusion and to facilitate recognition of the distribution patterns as they will exist on the final overlays.

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U. S. DEPARTMENT OF INTERIOR
OIL SHALE
ENVIRONMENTAL ADVISORY PANEL
Denver Federal Center

STATEMENT OF
WORK AND ORGANIZATION FOR:

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Denver Federal Center
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TERRESTRIAL BASELINE DATA ACCUMULATION PROGRAM

RIO BLANCO OIL SHALE PROJECT

ecology consultants, incorporated
p.o. 1057, fort collins
colorado 80522

OCTOBER 1, 1974

After the preliminary vegetation maps have been field-corrected and put into final working form, they will be combined to form a mosaic of the vegetation types, one for each vegetation association. These working copies will then be converted to finished, color-coded overlays which will be registerable to a standard 1:24,000 U.S.G.S. quadrangle map or photomosaic of the study area. The final product (fall 1976) will be a color coded and/or patterned transparent overlay for each of the vegetation types identified. These overlays can be used individually or in various combinations to superimpose one or more association distributions on the standard 7.5 minute U.S.G.S. quadrangle maps of the area.

1.3.1.4 Data Analysis

The data will be routinely summarized after each sampling period. Statistical and quantitative formulas adapted from Woodin and Lindsey (1954) and Potter (1957) will be used to analyze the data. Ordination diagrams will be utilized to indicate specific relationships, i.e., soil, aspect, or geologic formation preference by certain plant communities.

1.3.2 Forage production

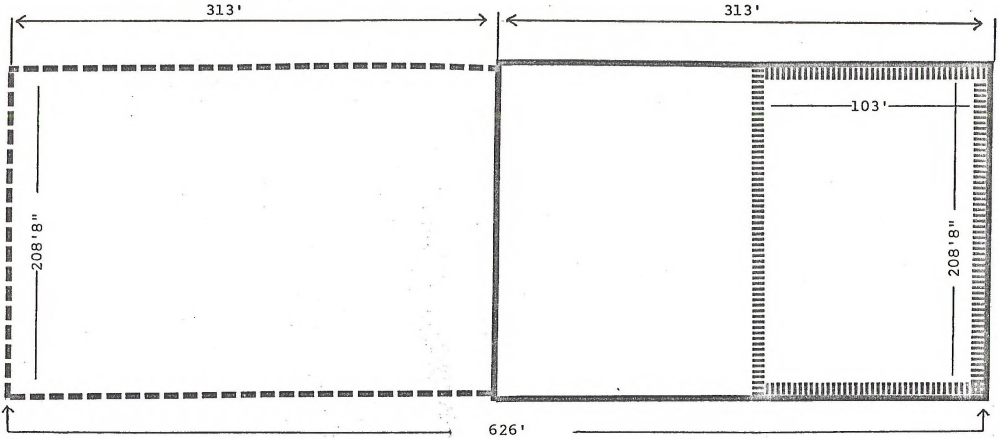
1.3.2.1 Grazing Exclosures

The objective of the grazing exclosures is to record forage productivity in controlled situations. The study will identify the effects of grazing and browsing on the major forage plants by definitive groups of herbivores. Forage production under specific grazing pressures can then be estimated.

Three grazing exclosures will be constructed in the study area. One exclosure will be built on Tract C-a and the remaining two constructed nearby at easily accessible locations. All exclosures will be situated in or adjacent to a pinyon-juniper stand which offers cover and a diversity of apparently utilized browse species.

Each exclosure will encompass a 3 acre area compartmentalized (or nested) in order to exclude specific groups of herbivores (FIGURE 4). One compartment of 1 1/2 acres will exclude domestic livestock and wild horses. The remaining 1 1/2 acres will also exclude big game animals. One half acre of the big game exclosure will be sectioned off to prevent entry by lagomorphs and rodents. Trapping stations will be utilized within the latter compartment to prevent encroachment by small burrowing mammals.

Sampling will be done in a 100 foot square grid located in the center of each compartment to leave an adequate buffer



Livestock Exclosure 1 1/2 acres

Livestock and Big Game Exclosure 1 acre

Livestock, Big Game, and Rodent Exclosure 1/2 acre

FIGURE 4. GRAZING EXCLOSURE DIAGRAM

zone between the grid and the fence. An additional 100 foot square grid will be established outside each exclosure. Such grids will be randomly sampled using ocular estimates in conjunction with the clip plot method, as described in Range Research Methods, U.S. Department of Agriculture (1963), for estimates of productivity. A herbage meter will be used to obtain a third value for comparative evaluations. These grids will be sampled during June, August, and September of 1975 and 1976.

1.3.2.2 Photo Plots

Photo plots will be established and marked within each compartment of each exclosure and at locations adjacent to the exclosures. These photo plots are designed to give a visual record of growth response by the major browse species under non-protective and differential protective measures as outlined above.

1.3.2.3 Data and Laboratory Analysis

The data derived from the ocular estimates, herbage meter readings, and the laboratory analysis of clip plot material will be statistically analyzed and the results expanded to give forage production in pounds per acre. Productivity estimates will be given after each sampling period.

1.3.3 Soils

1.3.3.1 Soil Sample Collection

The objectives of the soil sample collections are to characterize the soils at each vegetation sampling site in terms of specific physical and chemical properties which have ecological significance and to identify land stabilization problems in terms of identifiable soil characteristics. Soil samples will be collected from each of the vegetation sampling sites and the three exclosures during spring 1975, at the time the ultimate soils contractor is in the field.

These objectives will serve to define the plant-soil relationships operating in the various ecosystems in the project area. This in turn will provide a basis for engineering and rehabilitation decisions. Work outlined here will provide general soil characteristics at each of the vegetation sampling sites and at the exclosure sites.

Five soil samples of equal volume will be taken from each site and thoroughly mixed in a closed container to provide a composite sample for that site. Sampling will be done to a uniform depth of 12 inches, or to bedrock if shallower, with a 2-inch diameter hand auger. After screening to separate out coarse materials, a representative 250g subsample will be taken from each composite sample for laboratory analysis. Soil depth will be sampled by extending two of the auger holes in each set of five to a depth of 24 inches, or to the limit of hand augering,

if shallower. Soil erosion conditions in the vicinity of each sampling site will be rated as severe, accelerated, moderate, or negligible based upon standard criteria for these classes.

1.3.3.2 Laboratory Analysis

The laboratory analysis of the soil samples will provide data on the physical and chemical properties necessary to define the plant-soil relationships of the study area, and include:

Textural classification

Water holding capacity

Available plant nutrients, ppm

pH

Cation exchange capacity

Salinity, Mmhos/cm

Na, Meq/100g

Lime percentage

Organic matter percentage

Organic N, lbs/acre

The above determinations of physical and chemical soil properties will provide data appropriate to the climatic and edaphic conditions in the project area.

1.3.4 Small Mammals

The small mammal census program is designed to identify the species of small mammals that occur within Tract C-a and its contiguous area, to determine their absolute densities in and use of dominant habitats, and to develop a designation of important species. Seasonal periodicity of activity, reproductive effort and trophic relationships are to be described. Habitat preferences will be determined and species diversity values for the various habitats will be calculated to facilitate ecological comparisons between habitat types.

1.3.4.1 Live Trapping

A live trapping program will be initiated during October, 1974 and sampling will occur bimonthly thereafter through August, 1976. Within and adjacent to Tract C-a, six 7.29 hectare (18 acre) grids will be established to sample all major vegetation associations. Each grid will have dimensions of 270m x 270m and will consist of 133 stations, permanently marked with numbered stakes. The center of the grid will consist of 49 stations, in a 7 x 7 pattern, spaced at intervals of 15m. The remaining 84 stations, forming the boundaries of the grid will be spaced 30m apart (FIGURE 5). This grid size and pattern is designed to insure accurate estimation of population densities and home ranges for both the smaller

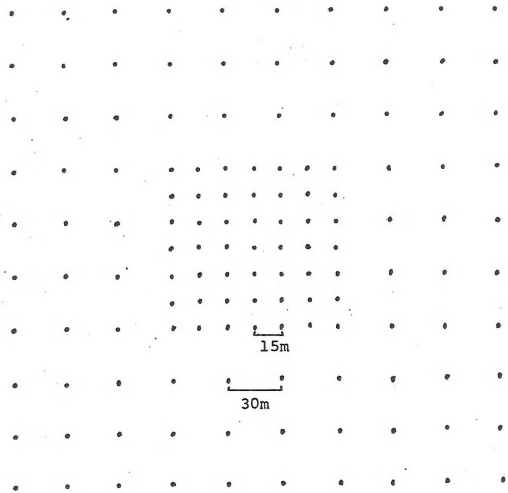


FIGURE 5. PATTERN AND SPACING OF TRAPPING STATIONS FOR THE LARGE (7.29 HECTARE) GRIDS.

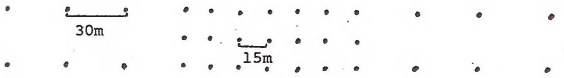


FIGURE 6. PATTERN AND SPACING OF TRAPPING STATIONS FOR THE SMALL (0.81 HECTARE) GRIDS.

rodents (mice and voles) and the larger, wider ranging ground squirrels and chipmunks.

Fourteen 0.81 hectare (2 acre) grids will also be used in the trapping program. These smaller grids will be established in the major habitat types in conjunction with the 7.29 hectare grids to provide a basis for accurate density estimation on the smaller grids. The major purpose of the 0.81 hectare grids is to evaluate the range of variation in small mammal use of major vegetation types which are not represented on the tract, and edge habitats (habitats created by the juxtaposition of distinctly different habitats). These grids will consist of 33 permanently marked stations in the same configuration as 3 lines of stations through the center of the larger grid (FIGURE 6). The types of vegetation sampled by the different sized grids are listed in TABLE 1 and grid locations are shown in FIGURE 7 .

A 3" x 3" x 10" Sherman live trap will be set at each station of all the grids. However, so that all the trapable animals will have an equal chance of being captured, an underlying assumption in most capture-recapture methods, an additional trap per station will be established at all grids where capture success exceeds 50 percent in any one trap night.

TABLE 1. SIZES AND DISTRIBUTIONS OF SMALL MAMMAL LIVE TRAPPING GRIDS WITHIN DIFFERENT VEGETATIVE COMMUNITIES ON AND NEAR TRACT C-a [1]

Vegetative Community	Large (7.29 hectare) Grids		Small (0.81 hectare) Grids	
	On Tract	Off Tract	On Tract	Off Tract
Pinyon-Juniper (North slope)	1		1	
Pinyon-Juniper (South slope)	1			1
Pinyon-Juniper (West slope)				1
Pinyon-Juniper/Sagebrush				1 [2]
Sagebrush	1		1	1
Greasewood/Sagebrush		1	1	
Rabbitbrush			1	
Mixed Brush		1	1	
Mixed brush/Pinyon-Juniper			1 [2]	
Riparian				1
Bottomland Meadow				1
Upland Meadow			1	1
Douglas Fir				1 [3]
Aspen				1

[1] The arrangement of small and large grids is designed to meet the following objectives:

Large grids are placed to obtain accurate density estimates on the five major vegetation types encountered both on and off the tract. Entire grids are committed to the three predominant vegetation types and one-half grid is committed to each less prevalent type. Grids sampling less abundant vegetation types are mostly located off the tract because the larger off-tract area provides a wider variety of sampling locations to choose from.

Holding the number of large grids to six permits the establishment of more small grids. Some of these are placed adjacent to large grids, to establish a basis for density estimates in other variations of the same type (such as Pinyon-Juniper on north and south slopes) by the formula:

TABLE 1. (Continued)

Grid estimates of population density for a given animal category in one vegetation type $\times$ Number of animals captured on a small grid in a variation of the type sampled by the grid / Number of animals captured on the adjacent small grid

Other small grids are placed to sample the zones of transition (edges) between major vegetation types and to sample vegetation types whose distribution is limited but which may contain species not occurring at other sites. Emlen strip-censusing locations for bird surveys will coincide with the small mammal grid locations.

2/ Grid established in edge habitat.

3/ 7 x 7 (15 m spacing) grid configuration.

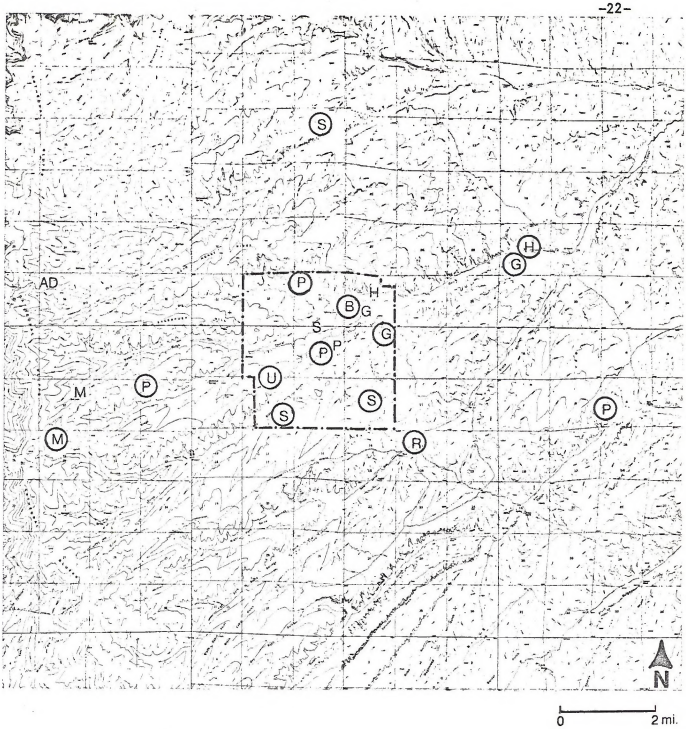


FIGURE 7. LOCATION OF SMALL MAMMAL LIVE TRAPPING GRIDS WITHIN AND ADJACENT TO TRACT C-a. THE LETTERS CORRESPOND TO THE LEGEND OF FIGURE 3. A LETTER ENCLOSED IN A CIRCLE INDICATES A SMALL (0.81 HECTARE) GRID. ALL OTHERS ARE THE LARGE (7.29 HECTARE) GRID.

Traps will be baited with a mixture of peanut butter and rolled oats, and will be checked for five consecutive days during each of the 12 sampling periods. To minimize dessication and death of trapped animals from the intense solar radiation characteristic of the Piceance Basin, cardboard will be positioned over each trap in a $\wedge$ shape to provide shade for animals captured during the day. During winter trapping periods, a wad of dacron batting will be placed at the back of each trap for bedding material, to prevent death from hypothermia.

Traps will be reset and rebaited as necessary. All animals will be distinctively marked by unique toe-clipping combinations and released. For each animal captured, species, sex, age class, reproductive status, general physical condition, capture location and identification number will be recorded on a standard trapping form. Distinguishing characteristics between all morphologically similar species that might occur in the Piceance Basin have been identified by ECI. Measurements of these characteristics will be routinely taken for all species captured where identification is reliant on such measures.

1.3.4.2 Collection of Animals for Laboratory Analysis

A snap-trap transect located within the ten major vegetative communities but far enough away from the live-trap grids to prevent interference will be run concurrently with the live-trapping operations at each plot. These transects will

employ 40 snap-traps positioned in the North American Census of Small Mammal program format (Calhoun, 1948) and will be operated until sufficient number of animals are collected for laboratory analysis or for 4 nights. The first individual of each species captured will be labelled, frozen and later transported on dry ice to our laboratory in Fort Collins to be prepared as a voucher specimen. The voucher specimen will be curated and stored in ECI's museum. In total, five voucher specimens of each species will be processed and curated. Subsequently, captured animals will be labelled as to date, location and collector, and will have the same information recorded as that described for the live captures. They will be immediately injected with 70 percent ethanol to preserve stomach contents. After transport to the laboratory, 20 individuals of each of the three most abundant species will be dissected and placental scars and number and size of fetuses will be recorded in females; in males, the size and state (descended, not descended) of testes will be determined. Any internal parasites discovered will be collected, and the general internal condition recorded.

Basic dietary preferences or food niches of small mammal species are becoming well-studied by mammalogists, and a solid literature basis is developing which can be employed to support interpretations of trophic relationships of mammals within various plant communities. The International Biological

Program's Grassland Biome work has provided recent data on small mammal diets through its Diet Laboratory in Fort Collins (see, for instance, Grant, 1972; Hansen and Moir, 1971; Flinders and Hansen, 1972). These data are available for our utilization, and have been achieved through a costly, time-consuming program. Extant data will be utilized whenever possible to support interpretations of dietary habits and trophic level position of the small mammal species found on or near Tract C-a, and stomach content analyses will be limited to confirming the applicability of existing data to the Piceance Basin region. To this end, stomach contents of five individuals each of the three most abundant species will be examined on a seasonal basis under approximately 30x magnification. Stomach contents will be placed in alcohol in a Petri dish which is marked in the center with an X. The material within the dish will be agitated and the particle on or closest to the X will be characterized as to whether it is of arthropod, vertebrate or vegetal origin. Vegetation will be differentiated between seeds and succulent parts. Fifty fields will be inspected from each stomach. Data will be presented as the percentage of microscope fields containing a given category of material, a format which is directly comparable with most literature presentations.

1.3.4.3 Pitfall Trapping

Pitfall traps for trap-shy animals and for animals not attracted to peanut butter bait will be established in each major vegetative community on and near the C-a tract. The trap system will consist of three plastic buckets, approximately the size of number 10 cans, placed in the ground open end up, flush with the ground surface and in a straight line. A 1-foot high drift fence (wire window screen) stretched over the center of these cans will guide animals into the traps. A thin coating of glycerin will be deposited on the bottom to minimize the possibility of small animals jumping out of the trap cans. Each set of pitfalls will be operated for 4 days during each small mammal sampling period and will be inspected daily for captures.

1.3.4.4 Night Spotlight Censuses

Night spotlight censuses will be established to record activity, distribution, and abundance of nocturnally active mammals, particularly rabbits, hares and predators. This census will be conducted on two clear nights during February, June, and October of each year along a 20 to 30 mile route which traverses all major vegetation associations within and adjacent to the C-a tract (FIGURE 8). The route will be driven at approximately 10 miles per hour with an observer situated on the right top of the vehicle operating a spotlight. All mammals sighted within a strip 25 yards wide on

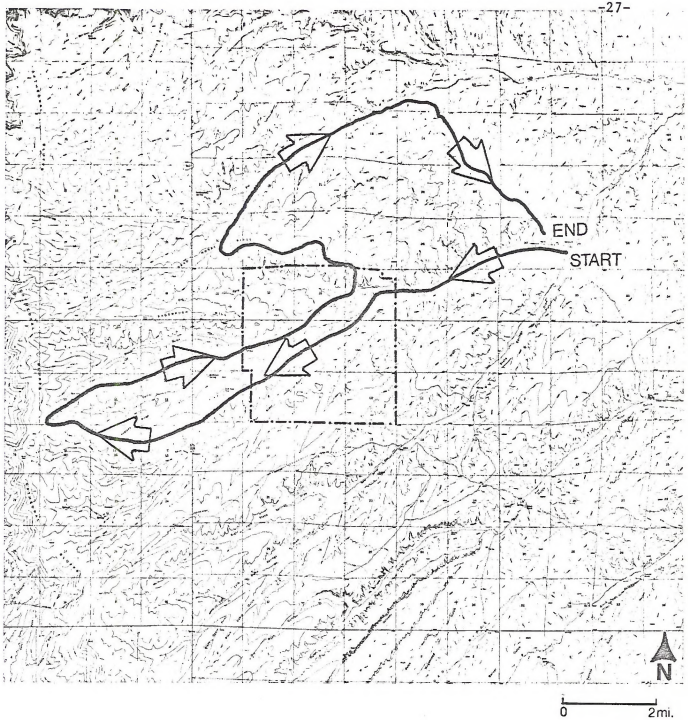


FIGURE 8 . NIGHT SPOTLIGHT ROAD TRANSECT ROUTE FOR MAMMALS AND OWLS

the right side of the vehicle will be recorded to species. Odometer readings to the nearest 0.1 mile will be recorded on a standard data form at the start of the census and each time a mammal is observed. Habitat will also be noted. At the start of each mile, the observer's accuracy in estimating the width of the 25-yard sampling strip will be checked to the nearest foot by direct taped measurement. The mean of these estimates will be used as the width of the sample strip. When multiplied by length of transect, total hectares sampled can be calculated. In addition, the census route will be run once during daylight hours while recording the habitat type at 0.1 mile intervals. Species habitat preference can then be determined by statistically comparing the observed number of sightings in a habitat type with the expected number based on a random distribution throughout all habitat types.

1.3.4.5 Bat Inventory

A group of small mammals that is often neglected in environmental baseline studies is the bat group. During the summer months of June and August of both years, ECI will employ two techniques to determine the distribution and relative abundance of bat species within and adjacent to the C-a tract.

Old buildings, rock overhangs, crevices and other likely roosting places will be searched during the daylight hours for bats. Active bats will be sampled by mist netting. At

dusk on four consecutive nights during the sampling periods, these nets will be placed horizontally 1-foot above ponds and water tanks showing bat activity on or near the C-a tract. Any bat striking the net while sweeping low over the water searching for insects will be caught in the pocket of the net. The mist net will be examined every 2 hours through the night. The first individual of each species captured will be sacrificed and prepared as a voucher specimen. Species, sex, date, location and collector will be recorded for subsequent captures and the bat will be released.

1.3.4.6 Other Investigations

Mammalian presence as indicated by sightings, tracks, scats, nests, dens, food remains or other definitive signs will be recorded on scaled field maps of Tract C-a and surrounding areas whenever noted during any field work. During winter censuses, track counts will be employed along standard transects. The final report will include a distributional map for each species documented within the study area, indicating all sightings, sign, and capture locations.

Locations of prairie dog towns, if any exist in the vicinity of the C-a tract, will be mapped from low-level aerial photographs and sightings recorded during aerial surveys of raptors, wild horses, and domestic cattle. These will be visited on the ground to look for the long trenches typically made by the

black-footed ferret (Fortenberry, 1972; Hillman, 1968; Snow, 1972), and for ferret tracks in the snow. It is unlikely that the species occurs today in the Piceance Basin. Most recent records of ferrets in Colorado have come from the eastern slope or the extreme southeast portion of the state (Cahalane, 1952; Lechleitner, 1969; Zaccagnini, 1974).

Hall and Kelson (1959) will be used for nomenclatural authority, and Armstrong (1972) will be used as the basis for the most current published literature on Colorado small mammal distributions.

1.3.4.7 Data Analyses

All small mammal trapping data will be summarized on standard data analysis sheets immediately after each sampling period. The most appropriate accepted statistical and quantitative ecological methods will be used to analyze the data. Population density of small mammal populations sampled in the live trapping program will be calculated by the Jolly-Seber stochastic model (Seber, 1973), Zippin's (1958) multinomial regression procedure and boundary strip methods (Dice, 1938, Machulich, 1951). Habitat preference will be determined by frequency of capture in different types, and Chi square tests and ordination. Species diversity within different vegetation communities will be indicated by Shannon-Weaver, Simpson, or alpha and beta diversity indices (Poole, 1974).

Mean, standard deviation, and 95% confidence limits will be routinely calculated for quantitative species population parameters such as home range and body weight. Additional analyses will be designed and performed as dictated by the developing data base.

1.3.5 Large Mammals

Investigations of the large mammals in the oil shale lease area will focus on determination of relative distributional abundance and population characteristics of mule deer, elk, and feral horses throughout all seasons. A major portion of the study, concerning mule deer, will be determining specific habitat usage patterns and migration paths of this economically important big game species as well as establishing the amount of winter mortality, sex ratios and age characteristics of populations utilizing the vicinity. Distribution and abundance of elk will also be determined. The feral horses which utilize land on and near Tract C-a will be studied to gather data on herd size as well as age classes. A comprehensive literature review on big game and feral horse utilization of the area will also be conducted as will interviews with personnel of the Colorado Division of Wildlife, members of the National Advisory Board for Wild Free-Roaming Horses and Burros, and personnel of state and federal agencies who have pertinent information on the large mammals in the area. All pertinent data and secondary information will be integrated into reports which define population concentrations, distributions, and identify critical habitat areas which should be maintained or treated specially.

1.3.5.1 Winter Surveys of Deer

Winter counts of mule deer and elk will be accomplished by using aerial census techniques. A small, high-wing aircraft

capable of low flights at a slow speed will be used for the counts which will be conducted twice monthly, commencing in late October, continuing throughout the winter and ending in April for each year of the study. Complete coverage of the C-a tract will be accomplished by low altitude flights which travel in southwesterly and northeasterly directions. The flight lines will parallel each other at approximately one-third mile intervals; each flight line will be in the opposite direction of the preceeding flight path. Approximate flight line paths are shown in FIGURE 9. Flight paths will be duplicated during each census period as much as weather conditions will permit.

In "Big Game Winter Range Analysis of Game Unit 22-Piceance" by Bertram D. Baker, the upper limits of the average winter range line for the Yellow Creek area are given at about 6850 feet elevation with a range of 6,500 to 7,000 feet between Duck Creek and Ryan Gulch. FIGURE 9 represents an approximate location of this upper range line in relation to Tract C-a. Much of the land to the east of Tract C-a is considered winter range in the Barcus-Ryan key area and most of Tract C-a would be considered winter range only during winters of light snow accumulation. Winter observations for mule deer on areas off Tract C-a will therefore be more heavily concentrated to the east of C-a than on areas to the west. The aerial census area on the east will survey an area of approximately 10 miles by 3.5 miles with Duck Creek as the northern boundary, the upper winter range line as

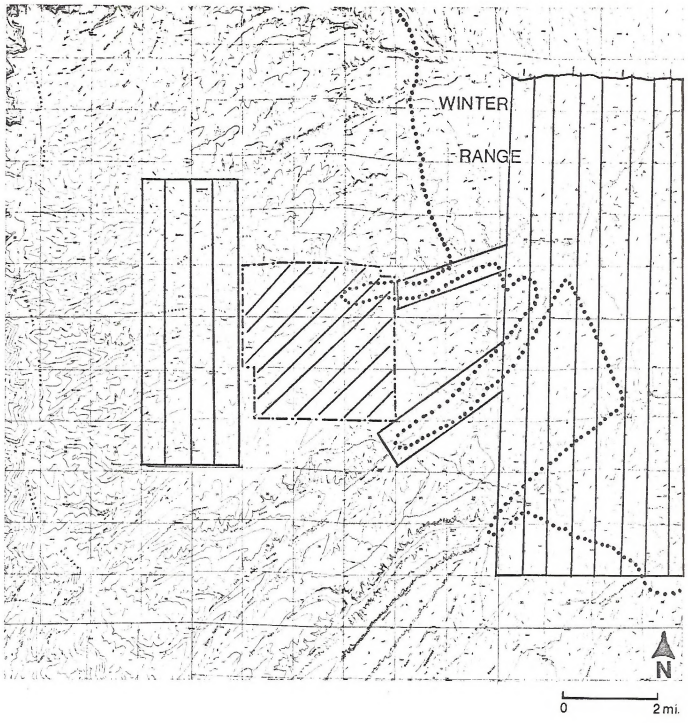


FIGURE 9 . APPROXIMATE LOCATION OF AERIAL CENSUS FLIGHT LINES AND LOCATION OF UPPER LIMIT OF AVERAGE WINTER RANGE.

——— Aerial census flight lines

••••••••• Upper limit of average winter range

the western boundary, Duckett Ranch on Black Sulfur Creek its southern boundary, and a line running north and south approximately 1/2 mile east of the Duckett Ranch as the eastern boundary. The flight lines will be approximately 1/2 mile apart and will run in north-south directions. A flight up and down Corral Gulch and one up Stake Springs Draw will also be made. A smaller area will be censused west of Tract C-a in a similar manner; the area will be approximately 2 miles by 5.5 miles, bounded on the north by Big Duck Creek, on the east by the C-a tract, on the south by Spruce Gulch. The western boundary will be approximately 3 miles west of the C-a tract.

Flights are planned to commence as soon after daylight as weather conditions permit. During the flights, two experienced observers will count individual animals and record them according to species, relative location on the transect, and when possible, according to age and sex. Portable tape recorders will be used to record data and allow constant observation of the transect zones during the flights.

This type of flight will provide information on the relative distributional abundance throughout the areas and within the seasons sampled, thereby indicating the utilization of Tract C-a habitats by wintering deer relative to surrounding areas. If a helicopter were used for the census flights, more precise estimates of deer numbers could be obtained, but the precision in obtaining information on distribution patterns of deer would

not be appreciably increased. Costs of helicopter counts are considerably higher than those of fixed-wing surveys by 300-400 percent; by using fixed-wing aircraft, many more surveys can be made per unit cost, thus providing considerably more information on uses of various localities, and on migrational movements, which are the primary objects of winter surveys at this point in the program. A helicopter is necessary, however, to determine accurately sex and age ratios of the animals and will be used in that segment of the study.

Soon after completion of each census flight, the information gathered will be recorded on data forms and maps showing animal distribution and relative abundance will be made.

1.3.5.2 Sex Ratio-Age Classes for Mule Deer

Sex ratio and age class determinations will be made during December of 1974 and 1975. Counts during this period should have good snow cover and bucks will still be carrying their antlers. The C-a tract area as well as locations off the tract area which contain concentrations of mule deer (determined by the winter counts) will be covered with a helicopter. All deer which can be classed will be categorized into one of the following classes: mature bucks, young bucks, does, or fawns. The observers will use a portable dictaphone to record sightings, and will discuss specific techniques for designating age classes with Colorado Wildlife Division personnel at Little Hills Station prior to the first census period.

1.3.5.3 Mule Deer Migration Route Determination

Since Tract C-a is located near or within parts of the winter range for mule deer which travel into the area from areas of higher elevation, it is important that migration routes traveled by these deer be determined to aid in planning access corridors throughout the area. By plotting and observing shifts in areas of herd concentrations throughout the seasons, the census data will yield strong inferences about the magnitude and timing of migrations, but to determine specific movement routes and patterns, other techniques are necessary. The Colorado Division of Wildlife has an ongoing project of tagging and marking deer in the Piceance Basin. The data obtained from these studies will be reviewed and incorporated into the reports as aids in interpreting data collected during the next 2 years. The approach ECI will use in this phase of the study involves observational flights every day for at least a 1-week interval during each of the migration periods of spring 1975, fall 1975, and spring 1976. Weather conditions permitting, flights will be conducted throughout Tract C-a and the adjacent areas in an effort to determine concentration areas on a daily basis and observe trails and actual migration movements as they occur. The flights will be attempted during peak periods of deer activity in the early morning and late evening. The timing of the complete sequence of flights must be scheduled to encompass the time of greatest migratory activity. This activity is dependent on

weather-snow conditions to a considerable extent. These conditions will have to be monitored and coupled with estimates of approximate time of migration activity and knowledge of mule deer behavior to aid in determining the correct time to do the flights. Coordination with big game biologists at Little Hills will aid in determining the period for flight startup. Data on deer movement obtained during the flights coupled with existing information collected by the Colorado Wildlife Division and relevant data gathered during the winter census flights should provide tentative indications of migration routes by mule deer.

1.3.5.4 Mule Deer Pellet Group Counts

Pellet counts will be used to determine summer utilization by mule deer on Tract C-a as well as the surrounding area. The pellet group counts will also yield information on winter range utilization and will supplement the winter aerial counts. Sampling intensities required to produce acceptable population estimates vary according to density of pellet groups, size of the area to be sampled, desired accuracy and many other factors. Most previous studies have indicated the need for a large sample size, even in areas of high deer density and even when relatively broad confidence limits on the estimate are acceptable. Since summer deer densities on the C-a tract vicinity range appear to be quite low and man-hour costs to obtain precise summer deer population estimates by direct count would be prohibitive, the following pellet group sampling program is proposed to determine

relative summer use of the regions in the study area. In each of the 9 sections comprising Tract C-a, a transect consisting of 25, 100-square foot circular plots spaced at 250-foot intervals along a straight line course will be established. The transect will be randomly located from a group of possible transects within each section of the tract. Four additional transects will be established in areas near the tract. Two of these transects will be established west of the tract within the winter census zone, and two will be established east of the tract. The location of these transects will be randomly selected from the sections in each of the two zones.

The establishment of the transects, after locations are selected will require placement of permanent "rebar" stakes to mark the plot centers, and clearing all old pellets from the plots. This phase of the program will be conducted in October 1974. Establishment during this period will allow calculations of winter range use for the 1974-75 winter period after inspecting the plots as soon as ground conditions permit in the spring of 1975. During the examination period, new pellet groups deposited since the initial plot preparation will be counted and removed. Groups deposited during the summer of 1975 will be counted and removed during September of that year. The same spring and fall examination sequence will be observed during the second year of the program. Scheduling in this manner will allow an estimate of deer use during the winter as well as an estimate of summer use expressed as deer days utilization per acre.

If the proposed sampling intensity provides estimates with too large confidence intervals, the program can be expanded after the first summer's data have been analysed. Present costing is based on a total of 13 transects. This program should allow comparisons of relative use of the different areas sampled by each transect in terms of deer days utilization per acre.

1.3.5.5 Overwinter Mortality Estimates

An aerial color infrared imagery technique which has been developed jointly by the Colorado Division of Wildlife and the U.S. Forest Service to measure deer mortality will be tested to determine its applicability for this study during the first year of the program. The CIR technique consists of flying aerial transects, statistically placed over the study area, to provide reliable estimates of winter mortality. All deer carcasses detected in the CIR imagery will be mapped. To provide data on sex and age classes, carcasses detected in the imagery will be subsampled by ground inspections.

In the spring of 1975, the CIR technique will be employed over the study area to obtain an estimate of overwintering mortality; the estimate obtained will then be checked using ground techniques similar to methods used by the Colorado Division of Wildlife in estimating winter mortality. The technique will involve stratifying the area according to expected level of deer mortality and estimating the mortality by walking transects chosen at random from among the various levels. Each transect

will be chosen at random from 10 possible locations within each section. The transect will be a belt 8 chains wide and 1 mile long, encompassing 64 acres, with a direction of travel which will cross the maximum number of contours. Aligning the transect in this manner will sample a large variety of elevational, slope, and aspect changes throughout the area.

The members of a four man crew will search each transect by aligning themselves over half the width of the transect, spacing themselves at one chain intervals, and walking the transect from one end to the other. The crew will then move over to the second half of the transect and search it back to the beginning point. Each carcass observed will be judged to be either a carcass from the current winter or from previous winters by condition of hair and bones. The lower jaw will be collected from each carcass determined to be from the current season.

The data obtained from the CIR technique and the ground transects will be compared to determine the reliability of the CIR technique for determining overwinter mortality in the vegetation types located on the study area. If the CIR technique yields reliable estimates of mortality, the ground census will not be necessary during the spring of 1976. However, if CIR does not provide reliable estimates, we will rely on ground transects during that sampling period.

CIR should allow for more rapid area coverage than ground censuses as well as offering a bird's eye view of the area.

The permanent imagery record generated by the technique will also be a good documentation of the existing conditions throughout the area.

In order to obtain data on the age classes suffering the greatest mortality, a lower jaw from each of the carcasses observed during the ground census and from a subsample of the CIR carcass determinations will be collected for age determinations. The jaw will be taken to the ECI lab for age determinations based on dental cementum annuli of an incisor tooth (Low and Cowan, 1963) and by tooth replacement and wear criteria. Judgmental aging will classify animals into the following age classes:

fawn - less than 11 months
yearlings - 12-23
mature - 24-95
old - 96+

1.3.5.6 Elk

The presence and distribution of elk will be ascertained by aerial observations at bimonthly intervals throughout the year. These flights will be in addition to the winter counts for deer, because the winter flights survey a fairly restricted area. The elk counts will be made in conjunction with counts of feral horses, large mammalian predators and domestic stock. Censuses of all of these groups will be accomplished concurrently during October, December, February, April, June and August for the 2 years, on nine north-south flight transects each of 10-

miles length. Transects will be flown along north-south extensions of the eastern boundary of zones 6, 4 and 2 (east of Tract C-a) on a transect bisecting Tract C-a, and at 1-mile intervals starting at the western border of Tract C-a and running west to the crest of the Cathedral Bluffs. Such a transect pattern concentrates most censusing within Corridor 1, the area where elk and feral horses are expected to be most common, yet provides coverage of the entire study area.

The plane utilized will be a small Cessna which has a design to allow slow stalling speeds, low altitude and excellent visibility. Whenever an elk or group of elk are spotted, their location and age (young vs. mature) will be recorded with a portable tape recorder. Before bulls shed their antlers during late-March or early-April, sex will also be indicated All elk observed on deer aerial censuses or depicted on aerial photographs will also be recorded on a locational map. During bird censuses and searches for blue grouse on the Cathedral Bluffs, locations of sighted elk or elk sign will also be recorded on field maps.

1.3.5.7 Feral Horses

Feral horses will be counted and mapped during the aerial transect censuses just described for elk. Locations of herds, the number of animals in the herd, and where possible the herd's age structure (foal and adult classes) will be recorded. When

ground workers encounter feral horses, similar information will be taken. Results of regular counts and age-class determinations presently ongoing by the Bureau of Land Management will be incorporated into the report on feral horses.

1.3.5.8 Data Analysis

Data which are suited for statistical treatments will be analysed to provide confidence limits of the estimates made. A programable, statistical calculator will be used for such analysis. Data which do not lend themselves to statistical evaluation will be interpreted based on knowledge of the literature and habits of the particular species being dealt with.

1.3.6 Mammalian Predators

The purpose of the predator investigation is to document the distribution and relative abundance of large (coyotes, bobcats, black bears and mountain lions) and small (ringtails, martens, weasels, badgers, etc.) predators within and adjacent to the C-a tract. A further objective is to determine from records compiled by state and federal agencies the impact these larger predators, particularly coyotes, are having on domestic livestock in the region.

1.3.6.1 Large Predators

Two census methods, the scent-station visitation technique and the siren-elicited howling response coyote census technique will be used to gather information on large predator populations. These techniques are accurate and reliable.

The scent-station visitation technique has been standardized by the Denver Wildlife Research Center (Linhardt and Knowlton, 1973). It has been used to survey the relative abundance of predators in 17 western states. One survey route extending through the C-a tract and adjacent areas will be established. The route will be 24 km (15 miles) long with 50 stations located 0.5 km (0.3 miles) apart. Stations will be alternated from left to right sides of the road and placed adjacent to the road edge. Each station will consist of a 0.9 m (3 foot) circle of sifted dirt, in the center of which

is placed a small perforated plastic capsule supported 1.25-2.5cm (0.5-1 inch) above the ground by a small stick. Capsules are filled with a granular fermented-egg attractant provided by the Denver Wildlife Research Center. Survey routes will be checked daily for five consecutive days every fourth month beginning October 1974, and continuing through June 1976. Animal visits based on tracks will be recorded for each station. The ground will be smoothed over each day so that new tracks can be distinguished on the following day (Linhardt and Knowlton, 1973; Carley, 1973).

The siren-elicited howling response coyote census technique will be used during the same period as the scent-station visitation technique. The following procedures, developed by Alcorn (1971a, 1971b) of the Bureau of Sport Fisheries and Wildlife will be used. A 48 km (30 mile) transect, consisting of siren stations 4.8 km (3 miles) apart, will be established through the C-a tract and adjacent areas. At each station an electric siren will be sounded for two complete pitch cycles (10 seconds), followed by a 1-minute listening period. A second two-cycle sounding of the siren will be followed by a 2-minute listening period. An additional 1-minute listening period follows the 2-minute period.

Data to be recorded at each station will be time, number of coyotes responding to the first siren, number responding to the second siren, total number of different coyotes responding

and general weather conditions. Sampling will be done after dark on two calm, clear nights during the scent-station visitation program.

Two other kinds of field evidence will be compiled on the distribution and relative abundance of large mammalian predators. During the 24 aerial censuses of big game animals in the winter months and the six summer aerial censuses of wild horses, raptors and domestic livestock, the observing biologist will record and map the location of any large predator. Other field data will result from recording locations of tracks in the snow during winter avian censuses and small mammal trapping activities. Sightings of large predators by personnel working in the field throughout the year, and locations of scats, dens and other definitive sign will be plotted on field maps. Locations of deer and livestock kills will also be noted, and evidences of predation or carrion usage will be recorded.

In conjunction with a literature review on specific information of past records of abundance and distribution of large mammalian predators in this area, State of Colorado Division of Wildlife personnel will be interviewed for records of damage claims to livestock, and for hunting kill and trapping records of predaceous mammals in the region. Government hunters from the Bureau of Sport Fisheries and Wildlife who have been taking coyotes in western Colorado from helicopters, will also be contacted for specific information on large predators in the

Piceance Basin. Present research projects by the Audubon and Sierra Club should provide important information, also.

1.3.6.2 Small Predators

Havahart and special live traps using appropriate baiting material will be routinely set in areas where small mammalian predators are suspected to occur. These traps will be regularly checked. Any animal caught will be identified as to species and sex, if possible, and released. A specimen will be made of each species captured, for documentation purposes. Location of captures, sightings by field personnel, scats, dens, and other definitive sign will be carefully plotted on field maps. This will aid in determining the distribution of small mammalian predators within and adjacent to the C-a tract.

1.3.7 Avifauna

The purpose of the avifauna census program is to identify what bird species occur within the study area on a seasonal and annual basis, to determine their density in and use of dominant habitats, and to develop an objective designation of important species. Habitat preferences and favored nesting habitats of breeding species are to be indicated. Songbird, gamebird and raptor species are to be investigated. The distribution of gamebird nesting is to be determined and sage grouse leks are to be located and mapped.

1.3.7.1 Songbirds

Quantitative censuses of songbirds residing in or utilizing habitats of the study area will commence during October 1974 and be continued on a bi-monthly basis thereafter. In each of the 12 count periods, 20 separate censuses will be conducted. The starting point for each census will coincide with the edge of the six main mammal trapping grids and the 14 smaller trapping plots as depicted in FIGURE 7 . Each census route will stay far enough within the vegetative association which is to be sampled to maximize homogeneity of habitat.

The Emlen strip census procedure (Emlen, 1971), which provides data from which absolute densities can be calculated, will be used for quantitative censuses. Transect length will be approximately 800m at each sampling location, and transects

will be permanently staked. To determine exact length of transects, the route of each will be plotted on an aerial photograph, and the length measured on the photograph, followed by appropriate conversion to meters.

Spacing of counts through the year and inventorying all major vegetative types will provide specific information on residence and migratory status of birds and on specific habitat preferences.

When nests are discovered on these counts and during other field activities, standard information on nesting habitat and contents will be recorded. These notes will indicate specific habitat preferences of various species breeding in the Piceance Basin, to supplement more general literature information on habitat requirements.

Nomenclature used in reports will follow the American Ornithologists' Union Checklist of North American Birds (AOU, 1957), as updated by the 32nd supplement to the checklist (AOU, 1973). Bailey and Niedroch (1965) and Davis (1969) will serve as the basis for previous records in the region.

1.3.7.2 Gamebirds

Mourning doves, sage grouse, blue grouse, chukar and various species of waterfowl are gamebirds using or potentially utilizing the tract vicinity. The Emlen strip census procedure works well for determining density of mourning doves, and

provides relative abundance information on other species of upland gamebirds.

According to Rogers (1968), a scattered blue grouse population might inhabit higher elevations of the Cathedral Bluffs. It is not expected elsewhere on the study area. Blue grouse, if found, will be censused at the height of their displaying season. Censuses will be made by traversing the appropriate habitat for three consecutive mornings and making hooting counts. Hooting territories will be mapped and identified as possible nesting areas.

Rogers (1964) describes sage grouse density on the study area as "light", and indicates this grouse has been observed in scant numbers on Cathedral Bluffs and on 84 Mesa. It is probable that this species maintains leks and nests on other portions of the tract and surrounding area. Strip censuses combined with observations made during other field activities and during aerial censuses during the strutting period should identify leks and nesting areas. Areas of breeding activity will be mapped and designated as nesting localities. Determinations of reproductive success for sage grouse and blue grouse will be based on production counts from young-per-adult ratios. If grouse are found in significant numbers on the tract or in adjacent areas, a 20-mile brood census route (Patterson, 1952; Rogers, 1964) will be traversed by 4-wheel drive vehicle on two consecutive mornings during mid-summer

of 1975 and 1976. When grouse are encountered, they will be flushed and all birds present tallied according to sex and age. Data will be reported on a birds/mile and young/adult basis, and related to literature values on production counts. The specific location of the brood census route and the final design of the brood count program will be developed in consultation with Colorado Division of Wildlife personnel.

The chukar has been introduced widely in western Colorado but currently has a patchy distribution in the state. As of 1964, Colorado Division of Wildlife distribution maps showed no populations of chukar within the Tract C-a area, but more recent introductions or population movements might have changed this distributional pattern. Such possibility will be determined by an interview with Dr. Clait Braun of the Wildlife Division. If it is now present on the study area, it should be encountered and documented during the 12 census periods. If the species is found, brood counts will be made in these areas. Density of mourning doves, a species which is likely inhabiting all vegetative communities in the area, will be determined from Emlen transect counts.

Potential use of the tract by waterfowl must be restricted to observations at the few small impoundments present in the area. During each census period falling within the duck

migration and breeding season, at least two ponds will be visited systematically, and number of individual ducks will be recorded. Specific ponds to be censused will be determined after initial appraisal of habitat quality of ponds for ducks. Waterfowl utilization in bird use-days will be calculated.

1.3.7.3 Raptorial Birds

Raptors noted during ground activities will be recorded as to species, age class and location. Sightings from Emlen strip transects will provide an estimate of relative abundance of more common species. Occupied and vacated nests will also be recorded during routine field work.

Bimonthly low-level aerial flights will be made; these flights will cover all likely raptor nesting and activity areas on the tract and adjacent areas, as judged from examination of aerial photographs and ground census activities. All raptors observed on these flights will be identified; location, habitat, and where possible, age class of each bird will be recorded. These flights will be made on days when the standard flights for elk, feral horses and domestic livestock are undertaken; initiation of raptor flights will be separate from these other censuses, however, to assure coverage of proper habitat and to permit thermals to develop. Flight view panels of standard width will be maintained, so area of coverage can be determined, leading to estimates of birds per species per km^2.

During April and June, 1975 and 1976, a raptor biologist will traverse areas of the tract and its environs which provide suitable eyrie sites, to locate nests and make a count of all breeding raptors. All locations will be mapped.

Special attention will be given to the possibility that the peregrine falcon, an endangered species, is breeding in the area. Mr. Gerald Craig, Chief Raptor Biologist for the Colorado Division of Wildlife, will be conferred with to obtain specific information which the Division has accumulated on this species, the prairie falcon, and bald and golden eagles.

During spring and fall of 1975 and 1976, a night road transect having 30 stops located 1-mile apart will be traversed on two nights. This will be done concurrently with small mammal spotlight counts. At each stop, all owls heard calling will be recorded. Owls and poor-wills observed during transit within the spotlight strip will also be recorded.

1.3.7.4 Data Analysis

Emlen strip census results will be analyzed according to methods given in Emlen's (1971) treatise. Coefficients of detectability will be calculated for each species to give power to the computation of absolute densities. Densities will be given as birds per square kilometer of appropriate habitat. Literature information on mean clutch size and mean nesting success for the prominent species will permit

estimation of avian productivity in the region, based on numbers of breeding pairs present. Calculations of species diversity will be made, employing indices suited to the normality of the data bank.

1.3.8 Reptiles and Amphibians

The purpose of the reptile and amphibian sampling program is to determine habitat preference, distribution and, when possible, abundance of all species of reptiles and amphibians occurring on and near the C-a tract.

1.3.8.1 Field Methods

A herpetological sampling program will be initiated during October, 1974 and continued over a 2-year period during April, June, August and October.

Previous studies in the vicinity of the C-a tract have shown that lizards are most abundant on the rocky, south facing slopes. Within this habitat type, both on and adjacent to the C-a tract, one-hectare grids will be established (FIGURE 10). On each plot, 81 stations will be permanently marked with numbered stakes. Stations will be spaced at intervals of 12.5m and patterned in a 9 x 9 grid. For each sampling period, these grids will be worked for 3 days during hours of peak reptile activity. Lizards will be live captured by hand, or with a monofilament noose. Each lizard will be distinctively marked by unique toe-clipping combinations and released. For each lizard captured, species, sex, snout-vent length, weight, microhabitat (type of substrate or vegetation on which the lizard was first seen), grid location, and condition of the

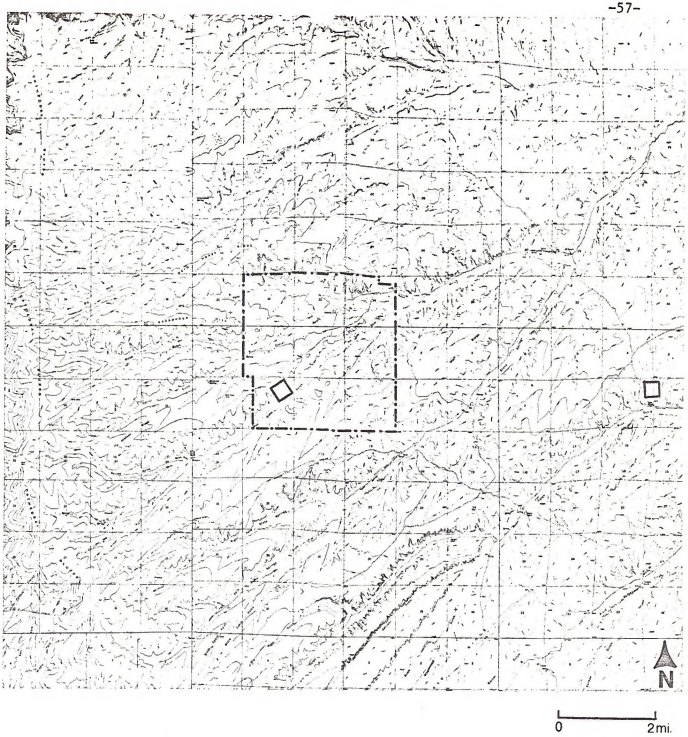


FIGURE 10. LOCATION OF THE 1-HECTARE LIZARD SAMPLING GRIDS

tail (intact, broken or regenerated) will be recorded on a standard trapping form. Weight will be determined with a calibrated spring scale.

Line transect methods will be employed to sample lizards, snakes, and amphibians in other major habitat types on and near the C-a tract. Five transects, each 1000m in length, will be run by two observers during each sampling period. Assuming each observer can see all active herpetofauna within 10m on either side, each transect will cover an area of 4 hectares. Each transect route will be located such that it traverses several vegetation communities. To insure that all vegetative communities are sampled over the 2-year period, transect routes will be relocated each sampling period. However, during the April and June sampling periods, at least 2 transect routes will include a major portion of the riparian habitat along Box Elder Creek, Stake Springs Gulch and Yellow Creek, since these are likely amphibian breeding locations. Also, two nights during the April and June sampling period will be spent sampling other likely amphibian breeding locations in the vicinity of the C-a tract. Species, habitat types and, when possible, sex and age class will be recorded for each individual encountered on the transect and breeding site visits.

The first individual of each species captured on the transect routes or breeding site visits will be killed by an injection of lethol, and prepared as a voucher specimen.

1.3.8.2 Other Investigations

Opportunistic observations by all field personnel together with the data collected on the grids, transects and amphibian breeding site visits will be used to construct distribution maps for all species.

Maslin (1959) will be used as the authority for nomenclature employed in reports.

1.3.8.3 Data Analysis

The data will be routinely summarized after each sampling period. Standard, accepted statistical and quantitative ecological methods, as discussed in the small mammal section, will be used to analyze the data.

1.3.9 Invertebrates

The objectives of terrestrial invertebrate investigations at Tract C-a are to obtain an inventory of the major taxonomic groups of invertebrates occurring in the principal vegetative communities, to identify important groups based on relative abundance and biomass, and for these to describe habitat requirements or preferences.

1.3.9.1 Field Methods

Sampling will occur during May, July, and September at each of nine locations on Tract C-a where small mammals and birds are routinely quantified. Field sampling will involve five basic operations. Five pitfall jars will be placed at each site to capture ground dwelling active species; these will be left open for three days and nights per sampling period. Each pitfall consists of a container placed in the ground with the top rim at ground level, partially filled with a preservative (glycerin). Ground-dwelling insects fall into the trap in their normal movements. Captures from one season can be compared with those from other seasons to determine changes in kinds and abundance of insects. One Malaise trap will be set up in each area to capture mobile airborne species and species which fly a portion of the time. Invertebrates captured will be removed periodically during the season by trained personnel working on the tract. Four samples per sampling period will be taken at each plot to

capture invertebrates which spend most of their life cycle on the vegetation. In areas where large, shrubby vegetation predominates, individual plants will be sampled using a metal frame trap covered with screen, which is dropped over the plant. A D-Vac unit will be used to remove invertebrates on the plant by suction; any litter which has accumulated at the plant base will also be sampled with this field-portable vacuum cleaner designed for this purpose. Where vegetation is mainly grasses and forbs, four 50-sweep samples will be taken.

General observation of plant damage by invertebrates, inspection of microhabitats not sampled (carcasses, logs), and counts of harvester ant nests per unit area will also be conducted. The latter will be accomplished by counting ant hills on the aerial photographs obtained for other purposes. Photographs of damage will be taken for identification and analysis. All samples will be labeled and preserved in alcohol for laboratory analysis.

1.3.9.2 Laboratory Methods

All samples will be hand sorted from debris, with those containing large numbers of invertebrates subsampled to cut down analysis time. Invertebrates will be identified to family, separated to species groups on the basis of morphological characteristics, and counted. Biomass will be estimated at the family level by using IBP data based on numbers per sample.

Groups deemed important in terms of abundance or biomass will be identified to species where possible, and confirmed by entomologists of the Smithsonian Institute or by other recognized experts. Access to the Colorado State University insect collection will also aid in identification of specimens.

A reference collection will be made containing representatives of all species captured and maintained for future reference and verification.

1.3.10 Domestic Livestock

Numbers of livestock on tract allotments and on allotments surrounding the tract will be determined and distributional concentrations will be indicated on a seasonal basis to determine movement patterns. Livestock, game animals and feral horses can become competitive if number of animals exceed the habitat's carrying capacity.

1.3.10.1 Field Method

Data regarding grazing history and use by domestic livestock will be obtained from Bureau of Land Management cattle allotment records. These records contain information on stocking rates, animal numbers, and season of utilization. Data from trend checks on forage production and utilization will be used to determine the proper carrying capacity of the region for all herbivores using the study area - domestic, feral, or native. An accurate estimation of carrying capacity will allow recommendations for allocating forage to each respective large herbivore category. Forage consumption by livestock can be extrapolated from known stocking rates. Subtracting this from per unit area carrying capacity x productivity calculations will reveal the allowable forage available for native herbivores and wild horses that is consistent with proper management of the range resource.

Since precise numbers of cattle using the area should be obtainable from agency files, aerial censusing will

concentrate on recording the locations of cattle aggregations and concentrations. Utilization of ponds will be determined from aerial procedures which in schedule and method will be those described for elk censuses. This information can be indicative of the extent of livestock competition with native and feral animals for water and forage. Mapping livestock concentration areas will supplement vegetative studies in delineating overused rangeland areas and defining potential conflict zones.

1.3.10.2 Data Analysis

Range analysis information available from the B.L.M. will be utilized to supplement the project's vegetation inventory. Department of Interior policies dictate that analyses of production and utilization be conducted at regular intervals and that information regarding vegetative types, condition, and productivity be maintained to a current standard. These data are available for public use and those data on the tract vicinity will be obtained and analyzed.

1.3.11 Rare and Endangered Species

Some species of mammals, birds and plants which are designated as "threatened" (USDI Bureau of Sport Fisheries and Wildlife, 1973), "rare" or "endangered" (Federal Register, various revisions) are expected on and in the vicinity of Tract C-a. If these species are present, they must be identified and their location and reliance on tract habitats determined.

1.3.11.1 Field Methods

Throughout earlier sections of this Statement of Work, specific, quantitative sampling techniques have been described which are to be performed within all major vegetative associations of the tract to inventory and enumerate the species of plants and animals present. In some instances, special procedures have been described which are aimed at discovering evidences of species classed as rare or endangered by the state or federal governments. Cumulatively, these techniques should ascertain the presence of such species. Once discovered, particular efforts will be given to determining the distribution and habitat utilization of the species on and near the Rio Blanco Oil Shale Project lease. Procedures for accomplishing this are those described throughout the scope of work.

1.3.12 Remote Sensing

1.3.12.1 Color Infrared Aerial Photography

Remote sensing technology has developed proven techniques for supplying high quality information faster and more economically than many conventional ground techniques. Many aspects of the terrestrial study will be enhanced by the use of color infrared aerial photography. The CIR will be used in developing the vegetation map of the study area. Other specific parameters that will be measured in the vegetation study include:

Ecological site definition

Vegetation type identifications and definitive compositions

Vegetation density

Ecological amplitude of major species

Tree size distribution

Vegetation condition (disease, insects, infestations, etc.)

Preliminary maps will be available in the later part of 1974 with the final product produced by July 1976.

The color infrared imagery used for mapping vegetation will also be used to map erosion condition and erosion susceptibility in the 6-zone area of concern. The specific parameters that will be measured are:

Percent vegetation cover (0-100%)

Erosion condition classes (stable, slight, moderate, critical, severe, as defined by the Bureau of Land Management)

Erosion susceptibility (3 classes, as defined by the Bureau of Land Management)

Color infrared imagery will be utilized in the development of wildlife habitat distribution maps for both large and small mammals. Because the distribution of most wildlife is directly related to the distribution of vegetation and water, much of the vegetation information can be used for delineating anticipated wildlife distribution patterns. Interpretation of the CIR photography will aid in identifying and locating vegetation types and/or specific sites in terms of the related significance for particular wildlife species such as blue grouse or elk. CIR will also aid in locating concentrations of burrowing mammals such as pocket gophers and prairie dogs. Prairie dog towns will be of special interest in the CIR interpretations. Any prairie dog town or suspected town sites located by CIR interpretation will be mapped. The mapped locations will be field inspected for evidence of the endangered, black-footed ferret.

CIR interpretation will also produce a map of all likely raptor habitat such as rock outcrops and cliffs. These maps will be utilized by field personnel to focus directly on all likely or identifiable sites.

Other application of CIR interpretations will include documentation of colonies per hectare of western harvester ants, locating archaeological sites, springs, abandoned fields or disturbed areas, and should aid in studying deer mortality on Tract C-a. The use of color infrared aerial photography will be continuous throughout the scheduled time of the project.

1.3.12.2 Mapping

The interpretation and mapping will be performed from color infrared aerial photography at a scale of 1:6000. This scale photography, to be taken September 1975 and 1976, will provide details that will allow location and identification of unusual or abnormal conditions in the vegetation patterns, archaeological sites, and other areas that may be of special interest. Vegetation maps developed from this scale will have more detail than maps developed from larger scale photography. This detailed vegetation distribution will facilitate detection of any changes in the vegetation or distribution which might occur at a future time.

Color infrared aerial photography at a scale of 1:2,000, to be taken May of 1976, will be utilized in determining the exact vegetation soil distribution and condition on the tract itself. This scale will allow determination and documentation of colonies per hectare of western harvester ants, sub-surface water, spring sites, abandoned fields, disturbed areas of small size, and as an aid in studying and developing techniques in determining deer mortality on Tract C-a.

1.3.12.3 Analysis and Interpretation

The color infrared aerial photography will be analyzed and interpreted during the first two weeks after delivery of the film from the subcontractor. The parameters discussed above will be reviewed with each new film set.

1.4 DATA SUMMARY AND ANALYSIS

All data collected will be summarized and stored on magnetic computer tapes. The original field data sheets will be duplicated and copies stored in project files. This information can then be quickly retrieved for review, documentation and subsequent analyses. Data summarization, transformation and more complex statistical and community analyses will be performed on a Hewlett-Packard Model 30 computer. Routine statistical analyses will be run on Monroe 1830 programmable computers. In some instances, specific statistical and quantitative ecological methods of data analysis and data comparisons have been indicated in various sections of the Technical Description section. Other, more general analyses will be routinely made whenever the type of data collected lend themselves to statistical examination. For instance, analysis of variance techniques will be performed on data which are collected in replicate, or in a series of samples and subsamples, allowing identification of those factors contributing most importantly to sample variation. Ordination techniques will be employed where they show promise depicting inter-community relationships between abiotic and biotic factors or between different biotic components.

When appropriate or possible, comparison of baseline data with data on and off tract and comparison of baseline data with data collected in the immediate or general vicinity by other agencies (such as the Colorado Division of Wildlife) will be

made. Special analytical comparison techniques to be utilized will depend upon the nature of data collected by others. Specific statistical tests used will depend on whether or not sample data are normally distributed. This will determine if standard statistical tests are applicable; if not, data transformation or non-parametric tests may be required.

Specification of the exact statistical procedures to be followed must in many cases await the inspection of field data. Then those tests which best utilize sample variance and the laws of probability to place confidence limits around given results, or the best techniques for measuring the statistical significance of observed difference between vegetation types or from one sampling period to another may be readily selected. The first annual report will develop a full iteration of the statistical and data analysis programs which will be employed, based on data collected during the October 1974 sampling period. Refined iterations will be developed as seasonal data become available, and the second annual report will detail the rationale and methodology of data analysis to be used for final comparisons and predictions.

1.5 USE OF EXISTING INFORMATION

A considerable store of objectively collected data and published literature exists on the biotic and abiotic resources of the Piceance Basin; these sources will be reviewed for their pertinence in supplementing observations and data collected on the tract to develop regional interpretations of ecosystems. Moreover, data collected over a period of years will permit better predictions of population dynamics and seasonal patterns of distribution of important biota. If data from Tract C-b investigations are available, certain of these can be incorporated into the framework of interpretive reports. In addition to information specific to Piceance Basin, an extensive literature is readily available which will assist in defining community and ecosystem relationships, species habitat and food requirements, and life histories. Some information on "indicator species," (i.e., those species which have special quantifiable sensitivities to environment stresses) and on rare and endangered species is also available in the circulating literature or in agency files.

ECI has achieved intimate familiarity with the ecological literature relevant to northwest Colorado through its long-term involvement in other projects in this area of the state. Its centralized library contains most reports on the flora, fauna and physiography of the specific region. It will obtain additional data from state and federal agency files.

To assure rapid accessibility of literature pertinent to ecological investigations in the region the company has begun to abstract and index information in a literature retrieval system which will be utilized for this project. The system consists of five index categories working independently for general literature search or working in concert as a cross-reference system to focus directly on the literature pertinent to the specific discipline being researched. Abstracts and key information are organized on punchcards utilizing a decimal or 1-2-4-7 system for index category designation. Standard rod-sorting techniques are applied.

Books, journal articles, dissertations, technical reports, and information stored on microfilm are indexed in this system. Data reports from state agencies will be added as they are obtained. Copies of title pages of all literature which will be cited in monthly, quarterly, annual and final reports will be placed in the project file, including information on the library holding the article, for purposes of documentation.

1.6 REPORTS AND MEETINGS

ECI will prepare and submit two copies each of monthly, quarterly and annual reports to the Management Consultant.

1.6.1 Monthly Reports

The monthly report shall be a progress report, briefly summarizing the program status regarding completion of field, laboratory and office investigation efforts. Unusual occurrences, potential problem areas which could affect projected schedules and objectives, and recommendations shall be included. The first monthly progress report shall be mailed to the Management Consultant within five working days after the first day of November, 1974 and each succeeding monthly report shall be so submitted within five working days of the first day of each calendar month thereafter. These reports will serve as a discussion basis for scheduled bimonthly meetings between ECI and the Management Consultants.

1.6.2 Quarterly Reports

The quarterly report shall be a data report and shall have appendiced all raw data which have been accumulated during the reporting quarter. Brief discussions of trends and preliminary interpretation shall be included whenever possible. Potential program modifications, which may be indicated by the evaluation of the preliminary results, shall be discussed. The first quarterly progress report shall be mailed to the Management Consultant on or before January 15, 1975, and each succeeding

quarterly report shall be so submitted on or before each April 15, July 15, October 15 and January 15 thereafter.

1.6.3 Annual Reports

A "first annual" report, which will present a preliminary statistical analysis plan, will be developed subsequent to summarization of field data collected during the October, 1974 sampling period. This initial report will include a complete description of the equipment, procedures and methods employed in the field for data collection and laboratory analysis. It will be submitted to the Management Consultant on or before January 1, 1975.

The "second annual" report will contain a statement of work accomplished, a full description and any interpretation that can reasonably be made of the results obtained, and a submittal of all raw data developed during the 12 months through the preceding September 30. Raw data previously submitted shall not be resubmitted in the annual report. It will be submitted to the Management Consultant on or before January 1, 1976.

1.6.4 Final Report

Two copies of a draft final report will be submitted 60 days after field work terminates. Two years of environmental baseline data will be organized and interpreted in an inter-disciplinary manner so that a unified evaluation of the terrestrial ecosystems studies can be made. Important species of plants and animals will be designated and rationale for their

selection documented. Maximum use will be made of graphical and statistical summaries so that the reader can digest the large volume of data. Wherever possible, data collected on and near the tract will also be integrated with other valid data collected at other locations in the region either concurrently or in the past, to develop a more comprehensive understanding of regional ecosystems and year-to-year fluctuations in biotic components. This will be especially important in regard to Colorado Division of Wildlife data on big game animal populations of the Piceance Basin. Format for the draft final report will be as follows: Preface, Acknowledgments, Executive Summary, Introduction, Methods and Materials, Results, Discussion, Conclusions, Literature Cited and Appendices. After review by the Management Consultant, 10 copies of a revised final report will be submitted to the Management Consultant.

1.6.5 Meetings

Bimonthly meetings will be held with the management consultant to review schedule, progress to date, program recommendations, and problems that require resolution through contractual or coordination channels. Meetings will be held in Denver, and will be in addition to unscheduled field meetings which are anticipated to be of frequent occurrence.

2. PROGRAM MANAGEMENT

2.1 PERSONNEL AND PROGRAM ORGANIZATION

As depicted in FIGURE 11, this program is organized under the concept that the Project Manager, Dr. James States, assumes primary responsibility for the project. His decisions and performance are subject to review and advice from ECI's Terrestrial Division Director, Dr. Stephen Martin and from the Quality Assurance Officer, Mr. Robert Macgregor. The entire program is to be conducted in close cooperation with the Project Management Consultant, Limnetics, Inc.

Under the supervision of the Project Manager, the actual performance of work will be directed by two key individuals - the Assistant Project Manager, Mr. Edmund Kelley, and the Field Supervisor, Mr. Thomas Turner. Their job descriptions include administrative tasks, detailed scheduling, the checking of accomplishments, and the writing of reports. Together with the Project Manager they will coordinate all field and laboratory activities and will also have the specific field and analytical responsibilities shown in FIGURE 11.

Separate from the three principals, and reporting directly to the Division Director, is the Quality Control Officer. His important function in providing quality assurance is detailed in section 2.2. The Division Director, in addition to providing a rapid avenue to the corporate administration, will take active

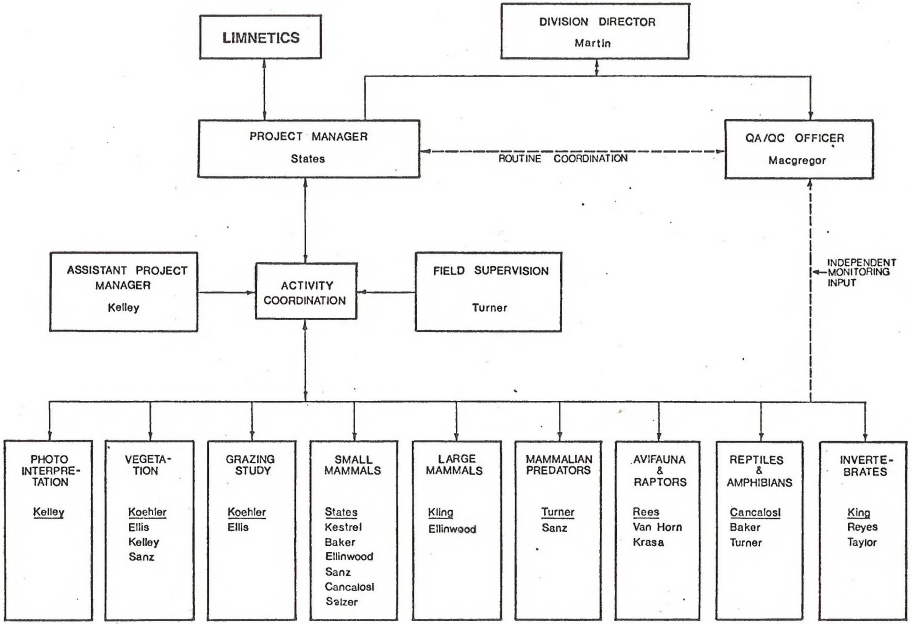


FIGURE 11. ORGANIZATIONAL SCHEME SHOWING INDIVIDUALS HOLDING KEY POSITIONS

participation in development of the data analysis program and in critical review of major reports.

Other individuals would confine their primary responsibility to the implementation and execution of particular sampling and analytical programs as shown in the organization figure.

2.2 QUALITY ASSURANCE/QUALITY CONTROL

ECI's extensive involvement with mining and power utilities companies has prompted the development of a comprehensive quality assurance program which meets the requirements of AEC 10CFR50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants". This program is being continuously updated and applied to all ECI projects to assure a product of uniform high quality and scientific precision.

Elements of the program presently are being compiled into a Quality Assurance Manual which will serve as the basis for standard quality control measures utilized in this project by management and staff.

Quality control assures the efficient completion of the project and the Quality Assurance Manual establishes, as routine, standard procedures covering all project elements. As a minimum for the Rio Blanco Oil Shale Project, these will include:

(1) Management organization

(2) Objectives control

(3) Procurement and purchases control

(4) Graphics quality control

(5) Document and data control

(6) Documentation procedures

(7) Equipment calibration and maintenance

(8) Non-conforming data control

(9) Corrective actions

(10) Quality control records

(11) Audits

(12) Technology review and procedure revision

(1) Project Management Organization

The Project Manager will have the primary responsibility for direction and supervision of all field, laboratory and administrative facets of this project, including conformance to scope of work specifications, schedule and budget, and project staff discipline. For all major tasks, written work orders will delineate details of work assisgnments. These project management functions will be subject to review and modification by the Terrestrial Ecology Director.

The Quality Control Officer independently assures that ECI's standards are maintained through all phases of project work. Quality assurance efforts by the Quality Control Officer will include establishment of standard field and in-house procedures; routine independent data quality and equipment performance checks; and corrective planning input at project management levels through the Terrestrial Ecology Director. The position of the Quality Control Officer in the project staff and the communications channels open to him are shown in FIGURE 11.

(2) Objectives Control

All activities will be carefully planned and scheduled on a daily basis. Project management and the Quality Control Officer will independently and continually monitor to certify that this schedule is correctly and effectively accomplished. Thus, the program will be under continuing review to assure that the objectives outlined in the scope of work are being fulfilled on a timely basis and to the depth necessary for accomplishment of overall program needs.

(3) Procurement, Purchases and Materials Control

All project procurements will be reviewed by project management and approved by the Quality Control Officer only if quality standards are met. Any associated invoices, parts lists and calibration or maintenance specifications will be chronologically filed by date of purchase for ready access. All purchases will be inspected for fulfillment of procurement specifications. All project materials, including vehicles and other field equipment purchased specifically for this project, will be inspected and maintained according to standard procedures and schedules outlined in the Quality Assurance Manual.

(4) Graphics Quality Control

All products of the graphics department will be reviewed for correctness by the originator. All corrections to be

made or marks signifying correctness will be made in non-reproducible blue pencil. All graphics output will be approved by project management after inspection and correction by the originator. Graphics which have been checked and reviewed become part of the project file under the appropriate report section heading.

(5) Document and Data Control

All incoming documents that pertain to the project including correspondence, data sheets, data analysis forms and field activity logs will be stamped, dated, and copied; a copy will be directed to the Project Manager for review and further routing. The original of all correspondence will be immediately placed in a limited-access Project File which will be housed outside the project work area. A working copy will be filed so that the "working" file, located in the project work area, will be always current. Original documents may not be removed from the Project File, and working copies must be signed out and returned promptly.

(6) Documentation Procedures

(a) Standards - A bibliography of all reference sources used as authorities for the identification of specimens and for nomenclature employed will be compiled and amended periodically. All statistical or mathematical treatments used in analyzing or summarizing data will follow recognized

formulae. Appropriate literature citations will be designated and added to the standards bibliography. Copies of title pages of all literature which is cited in monthly, quarterly, annual and final reports will be placed in the limited-access project file, including information on the library holding the article, for purposes of documentation.

(b) Sample control and identification - All sample collection will use standardized, carefully documented techniques. All samples will be labeled upon collection as to project name and number, location, date of collection, habitat, type of sample, preservation method, species (where appropriate) and name of collector. Once samples are returned to the laboratory, they will be maintained in a project work container until laboratory personnel are ready to process them. All handling and treatment of samples will be logged in a daily activity log which will become part of the project file.

(c) Sample handling, shipping and storage controls - All voucher specimens will be prepared for long-term storage in appropriate preservatives or maintained in insect-proof herbarium cabinets located in ECI's museum facilities. While in transit, samples will be protected by secure wrapping and shipping in trunks.

(d) Work instructions - Assignments involving substantial field, analytical or report preparation work will be issued

in written form. Detailed instructions on how progress and quality of work is to be documented will be included in the work assignment. After completion, the output will be reviewed by project management and the Quality Control Officer, and comments regarding the acceptability of work performed entered on the job description sheet. Any problems in quality of work will be immediately resolved with the staff member involved by project management. The completed forms will be permanently filed in project files.

(e) Sampling location verification - All locations of field stations will be marked with sturdy stakes. Locations will further be indicated on a detailed Site map to be verified by project management and independently by the Quality Control Officer.

(f) On-site data and activity logs - Daily logs will be kept of field activities and accomplishments. These logs will include data collected, records of unusual conditions or events, standard field data sheets and general field notes. All logs will be copied and originals kept in project files.

(7) Equipment Calibration and Maintenance and Lab Analysis Control

All sample analysis procedures and equipment functions will be periodically checked by standard monitoring and reviewing methodologies. Required calibration and maintenance of all field and laboratory equipment will be according to

standardized procedures and schedules outlined in the Quality Assurance Manual. Careful logs of all maintenance, inspection and calibration work will be kept in the project file. The Quality Control Officer will schedule and supervise calibration checks. New technology and literature pertinent to analytical methods will be reviewed by appropriate ECI staff members and evaluated as to usefulness in ECI's sample analysis program.

(8) Non-conforming Data Control

If non-conforming data or samples should be discovered during the course of the project, such data will be reported as "suspect". Samples and specimens will be so marked and identified. When feasible, data will be rechecked and the new results substituted for the data in question. The circumstances and rationale for all such changes will be carefully recorded in the project files.

(9) Corrective Action

Identifying the sources of non-conforming data and samples and initiating action to eliminate these sources is a primary concern of the Quality Control Officer. Routine review of field activity logs and data sheets and scheduled and unscheduled inspection of work activities and output will aid in elimination of problem sources, both from equipment and from personnel. Problem areas and recommended alternative courses of action will be brought to the attention of the division director as

soon as a problem is identified. He will see that project management implements immediate corrective measures. It is the prerogative of the Quality Control Officer to issue a temporary stop-work order if corrective action is not promptly taken.

Preventive corrective action, a planning function, is the joint concern and responsibility of all members of project management as well as the Quality Control staff. When a corrective action involves modifying a technique of sample or data collection or analysis, written revisions will be issued to all project personnel involved in the particular activity so that immediate conformance by all involved individuals will be assured.

(10) Quality Control Records

The Project Manager and Quality Control Officer will independently review all project files for completeness and accuracy. Specific quality control checks, schedules, correspondence and action records will be maintained as part of the project files. These records will include dates and outcomes of all calibrations and quality control checks of files, data, analysis results, etc.

(11) Audits

Audits of all aspects of project activities will be performed by the Quality Control Officer. These scheduled and unscheduled audits will include: files of field data and

activity logs, documentation and methodology files, calculation techniques and results, graphics output quality and consistency, laboratory daily records, testing and analysis results and project file completeness and organization.

In addition, field activity audits will be performed to verify conformance to ECI quality standards and scope of work specifications. Identified areas of deficiency will be subsequently reviewed by the Quality Control Officer to assure that corrective action has been implemented. All quality control records will be open to inspection by the purchaser or his designated representative at any time.

(12) Technology Review and Procedure Revision

If during the course of field or laboratory work or from literature investigations it becomes apparent that current procedures and techniques will not meet project information needs and objectives, a standard procedure for review and revision of techniques will be followed. Project management, in consultation with ECI staff members having appropriate technical and field expertise, will devise a revised procedure which will meet the objectives of the scope of work and will minimize time and data loss due to procedure modification. Any such changes in sample collection, data reduction, laboratory identification or other phases of project work will be fully documented and inspected and approved by the Quality

Control Officer before implementation of change. The purchaser will be consulted regarding proposed changes and informed of their rationale prior to implementation of the revisions. A separate section of the quality control file will contain records of all procedural modifications as well as complete documentation of methods, materials and scientific justification for such actions. This file will be available for inspection by the purchaser or a designated representative.

ECI has rented a house, complete with sleeping, cooking, and washing facilities, at the Colorado Wildlife Division's Little Hills Experiment Station. The Experiment Station, located 20 miles northeast of the C-a tract, will provide ECI quick access to the research area. The house, which has been reserved for the duration of the 2 year baseline study, will be used for housing field personnel, final staging of field activities, conferences, and storage of field equipment between sampling periods. It will serve as the project field communication center.

Two ECI vehicles, a 4-wheel drive Dodge Power Wagon and an International Harvester van, are fully committed to this project. Between sampling periods, one vehicle will be maintained at the Meeker airport and the other at Little Hills Experiment Station. Other vehicles will be committed as required. Also, a snow machine for sampling in certain areas during the winter months will be housed at the Experiment Station.

To permit immediate communication between field personnel and coordination of all field activities, the two vehicles will be equipped with 12 watt Citizen's Band 2-way radio units. A stationary unit will be housed in our facilities at Little Hills Experimental Station.

Data reduction equipment to be used on the project include 2 programmable Monroe computers; ECI is negotiating on the purchase of the Hewlett-Packard Model 30 system, including magnetic disc storage, line printer, graphic plotter and typewriter peripherals. This system will be utilized extensively on this project.

2.4 EXPERT TESTIMONY

At the request of Gulf-Standard or its Management Consultant, ECI shall provide expert testimony or other special appearances on the results or other matters concerning its terrestrial ecological investigations at Tract C-a. Such testimony shall be given at corporate meetings of Gulf-Standard, trials, hearings and at public presentations. For such preparation and testimony, ECI shall be additionally compensated at the hourly or per diem rate normally charged for such witness, plus reasonable expenses incurred in preparation of materials and the presentation.

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